Electrochemical Technologies for Wastewater Treatment

Treatment of complex industrial wastewaters via electrooxidation, electrocoagulation, and hybrid electrochemical technologies. Degradation of PFAS and other emerging contaminants.

Location: Main; In-person essential
Student Majors Accepted: Environmental Engineering, Chemical Engineering, Chemistry
Class Preferences: Juniors & Seniors
Important Selection Criteria: Interest in the project/research, critical thinking & problem solving skills.

Regulation of the PP2A tumor suppressor in normal and cancer cells

There are various projects available that deal with the characterization of the substrate specificity of the B55α/PP2A holoenzyme, its regulation in normal cells and its deregulation in cancer. (1) B55α/PP2A holoenzyme substrate specificity. This project focuses on determining the determinants of substrate specificity of B55α/PP2A holoenzymes using various unrelated substrates of this holoenzyme. We have a extensive collection of B55α and substrate mutants and more to be made to be tested for binding using transient co-transfections made in human cells grown in culture. The project involves cell culture, transfections, immunoprecipitation, western blot analysis and generation and maintenance of plasmids. (2) To identify the motifs in substrates recognized by B55/PP2A protein phosphatases. This project is centered on determining the amino acid residues that mediate the interaction of various substrates with the PP2A. We have an extensive collection of GST-mutants to characterize these interactions. More mutants will be generated based on bioinformatics docking analysis and the results of binding assays. The project involves cell culture, GST pull-down assays, western blot analysis and generation and maintenance of plasmids. (3) Role of B55alpha/PP2A holoenzymes in prostate cancer. The project involves cell culture, organoid growth, transfections, immunoprecipitations, western blot analysis and generation and maintenance of plasmids. It may also involve confocal microscopy. (4) Immortalization of primary prostate cells and establishment of primary cancer cells. The project involves cell culture, organoid growth, transfections, immunoprecipitations, western blot analysis and generation and maintenance of plasmids. It may also involve confocal microscopy. (5) Role of B55alpha/PP2A holoenzymes in prostate cancer. The project involves cell culture, organoid growth, transfections, immunoprecipitations, western blot analysis and generation and maintenance of plasmids. It may also involve confocal microscopy.

Location: HSC; In-person essential
Student Majors Accepted: Biochemistry, Biology, Bioinformatics - Genetics and/or Biochemistry and/or Cell Biology
Class Preferences: Freshmen, Sophomores & Juniors
Important Selection Criteria: Motivation for Science and Research. Background knowledge: Previous lab experience is NOT required.
Epigenetic Factors and the Microbiome in Disparities in Colon Cancer Outcomes

Racial disparities in colorectal cancer provide one indication that biology-based factors may be at play. Colorectal cancer mortality rates for African American men and African American women are higher than for Caucasian men and women. African American colorectal cancer patients also appear less likely to develop microsatellite instable cancers (a form of colorectal cancer with improved outcome, resulting from mutation or epigenetic silencing of genes involved in DNA mismatch repair) as their Caucasian counterparts. Moreover, African American patients who are asymptomatic are more likely to have large pre-cancerous adenomatous polyps present on colonoscopy screening than their Caucasian counterparts. These observations suggest that genetic and/or environmental factors that differ between African Americans and Caucasians are influencing both the initiation of colorectal cancer, as well as patient outcomes.

**Location:** HSC; In-person essential  
**Student Majors Accepted:** All Majors  
**Class Preferences:** Freshmen, Sophomores, Juniors & Seniors

Role of STIM-dependent calcium signals in T cell differentiation

T cells are critical players in adaptive immunity. T cells are made in the thymus and then released into peripheral blood where they seek out foreign agents. One of the first events that occurs in T cells when activated is a change in cytosolic calcium concentration. These calcium responses drive their differentiation into multiple differentiated T cell subsets that control the immune response in a manner dependent on both the duration and intensity of the calcium signal. We utilize a combination of cell lines and mouse models to understand the molecular events in control of calcium signal generation and T cell differentiation. This project would involve working closely with senior investigators in my lab, with the potential to learn multiple research approaches. Some prior students have earned publications.

**Location:** HSC; In-person essential  
**Student Majors Accepted:** Biology, Biochemistry  
**Class Preferences:** Sophomores, Juniors & Seniors  
**Important Selection Criteria:** Student must be enthusiastic with a genuine interest in learning research. Prior lab experience would be highly desirable but not required. Project involves cell culture, Western blots, cloning and fluorescence microscopy.
### Role of STIM-dependent calcium signals in T cell differentiation

T cells are critical players in adaptive immunity. T cells are made in the thymus and then released into peripheral blood where they seek out foreign agents. One of the first events that occurs in T cells when activated is a change in cytosolic calcium concentration. These calcium responses drive their differentiation into multiple differentiated T cell subsets that control the immune response in a manner dependent on both the duration and intensity of the calcium signal. We utilize a combination of cell lines and mouse models to understand the molecular events in control of calcium signal generation and T cell differentiation. This project would involve working closely with senior investigators in my lab, with the potential to learn multiple research approaches. Some prior students have earned publications.

**Location:** HSC; In-person essential  
**Student Majors Accepted:** Biology, Biochemistry  
**Class Preferences:** Sophomores, Juniors & Seniors  
**Important Selection Criteria:** Student must be enthusiastic with a genuine interest in learning research. Prior lab experience would be highly desirable but not required. Project involves cell culture, Western blots, cloning and fluorescence microscopy.

### Genetics and Epigenetics of sex-specific expression patterns in early embryogenesis

We are investigating differences between male and female mouse embryonic stem cells and mouse embryos, and identifying the mechanisms by which these early differences are established. We integrate gene expression, DNA methylation and chromatin conformation analyses with bioinformatics to establish how sex biases affect cellular phenotypes in health and disease.

**Location:** HSC; In-person essential  
**Student Majors Accepted:** Biology  
**Class Preferences:** Juniors & Seniors  
**Important Selection Criteria:** Basic laboratory skills, such as pipetting, running gels, PCR and making solutions required.
The role of extracellular vesicles in vascular disease

Atherosclerosis, hypertension and aneurysms are the major causes of cardiovascular disease (CVD) including heart attack and stroke. Despite recent advances in clinical therapies, CVD remains the leading cause of morbidity and mortality world-wide. Thus, there is a need to discover the underlying mechanisms that lead to CVD. Inter-cellular communication is essential for maintenance of blood vessel homeostasis and disease development. Our laboratory is interested in a new mechanism of cell-cell communication which involves extracellular vesicles (EV). These vesicles carry unique cargo (lipids, proteins, miRNAs and DNA) which can be transmitted to target cells as well as serve as biomarkers which indicate the health status of the vasculature. Specific projects focus on 1) characterization of EVs in vascular health and disease 2) functional effects of EVs in the vasculature and 3) the potential for EVs to act as therapeutic agents to treat CVD.

Location: HSC; In-person essential
Student Majors Accepted: Biology, Biochemistry, Chemistry, Bioengineering
Class Preferences: Freshmen, Sophomores, Juniors & Seniors
Important Selection Criteria: Seeking motivated students who desire to gain hands-on experience in basic biomedical research.

The role of YAP and Vitamin A signaling in cardiac development

Congenital Heart Disease (CHD) is a leading cause of mortality in kids. This project seeks to understand regulatory mechanisms that underly heart development. The overarching goal is to improve tools for prevention, cure and diagnoses of CHD. We investigate how the Vitamin A, an essential nutrient, regulates gene expression during the formation of the heart. We use mouse models, human embryonic stem cells and cardiac organoids to identify new regulatory mechanisms of the Vitamin A signaling essential for proper heart development.

Location: HSC; In-person essential
Student Majors Accepted: Biology/sciences
Class Preferences: Freshmen, Sophomores, Juniors & Seniors
Important Selection Criteria: The candidate has to be motivated, willing to participate actively in the lab and responsible with their own experiments.
Causes of Heart Failure with Preserved Ejection Fraction

Heart failure remains the #1 cause of death in the US. Ischemic heart disease is still a major problem, but a different and distinct for of heart failure, termed heart failure with preserved ejection fraction (HFpEF) is a growing problem. And there are not established therapies for this problem. The studies in progress are exploring the role of cardiac myocyte relaxation defects and stiffening of the extracellular support system (matrix) in the development of HFpEF. Studies in animal models and in-vitro are exploring the fundamental bases of HFpEF, and exploring novel therapies.

Location: HSC; In-person essential
Student Majors Accepted: Health professions
Class Preferences: Juniors
Important Selection Criteria: Students will need to work in teams.

Stem cell therapy for cardiac repair

The project would help in understanding different mechanisms that could be involved in heart repair after stem cell or exosomes transplantation after cardiac injury. Immune response is one of the major events that occur after injury. We would study how stem cells can play a part in modulating immune response after myocardial infarction. We will also study interaction of stem cells and other heart cell types including fibroblasts and myocytes.

Location: HSC; In-person essential
Student Majors Accepted: All majors
Class Preferences: Sophomores, Juniors & Seniors
Important Selection Criteria: N/A
Optimizing Prehospital Stroke Systems of Care-Reacting to Changing Paradigms (OPUS-REACH)

The Optimizing Prehospital Stroke Systems of Care-Reacting to Changing Paradigms (OPUS-REACH) is a consortium of nine health systems committed to improving stroke care. Approximately, one year ago, nine hospitals formed the OPUS-REACH consortium with the intention of studying the care of LVO stroke patients. With Temple University as the hub, the network developed and implemented a research plan to create a registry of real world LVO stroke patients. The registry includes data from prehospital dispatch to ninety-day functional outcomes. Students will be responsible for assisting Dr. Isenberg with data collection, data cleaning, and data analysis. Students will learn about the prehospital care of stroke patients and stroke systems of care.

Location: HSC; Virtual or computational research  
Student Majors Accepted: Public Health, Nursing, Data Science  
Class Preferences: Sophomores, Juniors & Seniors  
Important Selection Criteria: Good organization skills, knowledge of working with data sets, basic medical knowledge

Hybrid Archaeosomes with Extraordinary Stability and Controlled Release Capability

This research aims to design, construct, and test a new thermosensitive liposome drug delivery system that can overcome the issues of stability, controlled release, and target specificity altogether in the same single formulation and achieve a much higher anticancer efficacy compared to conventional thermosensitive liposomes. Specifically, we plan to develop hybrid archaeosomal drug containing archaeal tetraether lipids and diester lipids, which will be extraordinarily stable and inactive at the body temperature and can be turned to actively deliver drug molecules and kill cancer cells in the tumor areas that are subject to local hyperthermia treatment (i.e., from 37 to 42-44°C). The ultimate goal is to develop this smart material-based liposome formulation into a new clinical approach that will significantly increase the overall anticancer therapeutic efficacy and reduce the side effects of chemotherapy. Through this project, students can learn how to grow thermoacidophilic archaera, isolate tetraether lipids from archaea cells, make archaeosomes and archaeosomal drugs, characterize physical properties of archaeosomal drugs and their interactions with serum proteins and mammalian cells.

Location: HSC; In-person essential  
Student Majors Accepted: Chemistry, Biology, Biophysics  
Class Preferences: Freshmen, Sophomores, Juniors & Seniors  
Important Selection Criteria: general chemistry
Deciphering the role of STAT2 in colorectal cancer

Cancer is a very complex disease driven by multiple genetic alterations. The focus of my research is to investigate the mechanism by which the transcription factor STAT2 promotes tumor progression in colorectal cancer. The long-term goal of this project is to determine how STAT2 cooperates with tumor oncogenes to enable tumor progression, conversion of benign lesions to malignant and metastasis. Understanding this process will lead to the development of novel therapeutic interventions to treat colorectal cancer.

Location: HSC; In-person essential
Student Majors Accepted: Biology and Biochemistry
Class Preferences: Sophomores, Juniors & Seniors
Important Selection Criteria: No prior research experience is required. Good communication skills, attention to detail and able to follow directions. Self-motivated, eager to learn.

Molecular control of vascular remodeling and lymphangiogenesis

The focus of the project is to identify novel signaling pathways that regulate vascular angiogenesis and lymphangiogenesis, one of the major cardiovascular problems. Reticulon family proteins (RTN) are mainly localized to endoplasmic reticulon (ER) and regulate mitochondria associated ER membrane (MAM). In this project we are using genetic modified animal models, cellular and molecular techniques to uncover how Nogo-B, the only RTN-4 family protein expressed in vessel wall, regulate MAM remodeling in endothelial cells, and vascular and lymphatic angiogenesis in diabetes.

Location: HSC; In-person essential
Student Majors Accepted: Biology, Biochemistry, or Pharmacology
Class Preferences: Sophomores, Juniors & Seniors
Important Selection Criteria: Highly motivated and responsible. Basic cell and molecular biology techniques and understanding of human physiology are a plus.
The mechanisms of lung injury

Multiple factors can induce lung injury leading to pulmonary diseases such as emphysema or fibrosis. Our goal is to determine the mechanisms of lung injury using cell lines and samples obtained from patients with these diseases. We use various laboratory methods in our projects.

Location: HSC; In-person essential
Student Majors Accepted: N/A
Class Preferences: Freshmen, Sophomores, Juniors & Seniors
Important Selection Criteria: N/A
Exosomal Lipid Biomarkers of Oligodendrocyte Pathology During Fetal Alcohol Exposure

Exosomal Lipid Biomarkers of Oligodendrocyte Pathology During Fetal Alcohol Exposure

Introduction: One structural hallmark of Fetal Alcohol Syndrome (FAS) is a massive loss of neurons and oligodendrocytes (OLs). Dysregulation of lipids in myelin leading to apoptosis of oligodendrocyte precursor cells (OPCs) and altered OL differentiation has been shown in FAS rodent model but there are significant gaps in our understanding of the FAS specific mechanisms of OL lipid loss and enhanced dysmyelination in the human fetus. We recently demonstrated an EtOH-dependent decrease in myelin basic protein (MBP), toward OPCs, and an increase in caspase-3 activity and toxic TNF-α in the human fetal brain at early gestation. Free fatty acids (FFAs) effects are mediated via specific G protein-coupled receptors (FFARs), influencing OL development and myelination. We hypothesize that FAS is associated with a deficiency in the FFA ω-3. We postulate that OL-derived exosomes (OL-ES), which can be isolated from maternal serum, carry FFA biomarkers for FAS.

Methods. Blood samples that were collected from EtOH-exposed pregnant women and controls, will be used in this study, stratified by gestational age, gender, and race according to IRB protocol. OL-ES will be isolated using MBP as a late OL marker from maternal blood (250 μL). EtOH-associated dysmyelination will be assessed. OL-ES mRNA will be assayed by ddPCR for OL markers and FFAR expression. OL-ES MBP and FFAR protein levels will be quantified by ELISAs (normalized to marker CD81) and flow cytometry assays.

Previous Results. Downregulation of FFAR was greatest in EtOH-exposed cases (n=6). Statistically significant downregulation of the MBP mRNA and protein levels was also found in EtOH-exposed OL-ES, but not in non-pregnant women. New cases, stratified by gender, age, depression and obesity status will be studied for lipid biomarkers for FAS.

Conclusion: Non-invasive assessment of fetal OL-ES biomarkers offers an opportunity for translational confirmation of pre-clinical findings in clinical studies. Future studies should focus on the correlation between OL-ES markers and clinical phenotype/outcomes in FAS offspring and could further lead to clinical trials aimed at dietary corrections of the lipid abnormalities (e.g., dietary ω-3 supplementation), to reduce dysmyelination in children with FAS.

Location: HSC; In-person essential
Student Majors Accepted: Neuroscience, Biology, Science, Genetics, Molecular Biology, Music, Pharmacy
Class Preferences: Freshmen, Sophomores, Juniors & Seniors
Important Selection Criteria: Demonstration of self-motivation; Commitment required to successfully accomplish project goals; Accuracy in preparation and performing experiments; Demonstration of passion to the research; Dedication to the research endeavor
## Prenatal alcohol exposure disrupts fetal eye and brain development in humans

**Introduction:** Prenatal exposure to ethanol (EtOH) can result in a complex developmental abnormality called fetal alcohol syndrome (FAS). Diagnostic criteria include microphthalmia, microcephaly and other somatic and behavioral abnormalities. But not every child born to a mother who drank alcohol develops FAS or its partial form, fetal alcohol spectrum disorder (FASD). If diagnosis could be made during gestation, it could allow development of timely therapeutic interventions.

**Methods:** Fetal brain and eye tissues were collected at 11 to 21 weeks gestation. The EtOH-exposed group and controls were matched for gestational age (GA), fetal gender, race, and maternal BMI, and were analyzed using ELISA, flow cytometry, immunohistochemistry, western-blotting, and the Caspase-3/7 Glow assay. RNA expression was assessed using real-time quantitative RT-PCR (qPCR) and droplet digital PCR (ddPCR), using Pearson correlations for p-values. Eye morphometry was performed on paraffin sections, using a sliding digital caliper. Maternal blood samples were used for isolation of fetal brain-derived exosomes, (FB-Es) and oligodendrocyte derived exosomes (OL-Es), using Tag1 and myelin basic protein (MBP) as late OL markers. EtOH-associated dysmyelination was assessed by fetal tissue MBP and BDNF levels. OL-E mRNA was assayed by ddPCR for MBP expression. OL-E MBP and BDNF protein levels were quantified by ELISA (normalized to exosome marker CD81). An in vivo rat FAS model was established for studies of toxic effects of EtOH on rat fetal brain and eye development.

For this study, maternal blood samples will be used to isolate fetal brain-derived exosomes, and exosomal biomarkers will be investigated by ddPCR and ELISA.

**Previous Results:** Twenty human EtOH-exposed cases (1st or 2nd trimester) were compared with 20 GA-matched controls. EtOH exposure was associated with a consistent pattern of reduced eye and iris diameter. Markers of synaptogenesis were reduced, and caspase-3 activity was increased in human fetal brain samples. The reduction in eye diameter correlated with levels of EtOH intake (p<0.001). EtOH-associated caspase-3 activation correlated with decreased eye size (p<0.0003).

Studies in the rat FAS model showed similarly increased levels of activated caspase-3 in the FAS pup brains compared to controls. Body and brain weight were significantly lower in the EtOH groups at P8 and P15. Levels of MBP and peripheral myelin protein-22 (PMP22), which play important roles in OL development and myelination, were reduced in EtOH-exposed human fetal brains and eyes. Levels of b-catenin were increased, and BDNF decreased in the EtOH groups of both human and rat brains. These molecules are essential in neuronal development. There was a strong correlation between smaller eye size and decreased levels of exosomal MBP protein (R=0.9128; p=0.00061) and exosomal miR-9 (R=0.70337; p=0.02), and a moderate correlation with exosomal mRNA levels for MBP (R=0.51672; p=0.1) and BDNF (R=0.4, p=0.2).
Prenatal alcohol exposure disrupts fetal eye and brain development in humans cont.
For this study, novel non-invasive tool (using maternal blood) will be proposed to identify exosomal biomarkers whose expression level is correlated with the fetal eye diameter changes upon prenatal alcohol exposure.
Conclusion: Prenatal EtOH exposure hinders development of the eye in a dose-dependent manner, resulting in microphthalmia, which can be detected in histological sections of human fetuses as early as 11 wks GA, before these features of FAS/D can be measured by current imaging methods. The present data suggest that some molecular markers that can be measured in maternal blood correlate strongly with the anatomical hallmarks of FAS(D). Future studies might validate the use of FB-Es or OL-Es as non-invasively assayable sources of biomarkers to predict which at-risk fetuses will be born with FAS(D).

Location: HSC; In-person essential
Student Majors Accepted: Neuroscience, Biology, Molecular Biology, Genetics, Science, and others
Class Preferences: Freshmen, Sophomores, Juniors & Seniors
Important Selection Criteria: Self-motivation and commitment required to successfully accomplish project goals; Preparation, responsibility, activity;
Passion and dedication to the research.
Spinal cord injury in MMC

Myelomeningocele (MMC), the most common and severe type of spina bifida, is a devastating congenital neural tube defect. The defect is characterized by protrusion of the spinal cord and meninges through a pathological opening in the overlying vertebrae and skin, leaving the spinal cord exposed to the intrauterine environment. The underlying defect leads to prenatal injury to the exposed spinal cord and a spectrum of associated abnormalities leading to life-long disabilities.

One segment of our research focuses on understanding of pathophysiological alterations associated with the prenatal injury to the exposed MMC spinal cord and exploring the causative factors and possible mechanisms by which these alterations are induced. This work includes examination of mechanisms underlying the formation of astrocytosis, analysis of extracellular matrix imbalance as well as other pathophysiological derangements that parallel the injury. In addition, our research involves analysis of MMC-associated changes in the amniotic fluid components and identification of novel diagnostic biomarkers for MMC.

For these studies, we use rat model of MMC and a variety of in-vitro systems. By elucidating the cellular and molecular mechanisms underlying spinal cord injury in MMC, we aim to develop novel approaches for the prenatal treatment of this defect to lessen the burden of neural injury and to identify potential biomarkers for the diagnostic strategies that can aid in the detection and management of MMC.

Location: HSC; In-person essential
Student Majors Accepted: Biology, neuroscience.
Class Preferences: Sophomores & Juniors
Important Selection Criteria: Biology, biochemistry or neuroscience major courses.

Chemogenetic evaluation of neural function

1) Chemogenetic stimulation of descending motor pathways in juvenile rats to promote functional recovery after spinal cord injury.
2) Evaluation of neurocircuits involved in learning and memory associated with rehabilitation after spinal cord injury.
Non-CST Spring 2022 Semester Undergraduate Research Opportunities

**Location:** HSC; In-person essential
**Student Majors Accepted:** Neuroscience, engineering, chemistry
**Class Preferences:** Juniors & Seniors
**Important Selection Criteria:** Techniques used in the lab: spinal surgery, gene therapy, immunohistochemistry, western blot analyses, electrophysiology, motion capture, kinematics.

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### Analysis of transgenic mice to study Peripheral nerve degeneration, tumorigenesis or regeneration

Young-Jin Son  
yson@temple.edu  
LKSOM  
Neural Sciences

Student(s) will be involved in immunohistochemical, Western blotting and/or electron microscopic analysis of various transgenic or knockout mice in which expression of Yap/Taz or related factors are removed or increased selectively in Schwann cells. We aim to understand how Yap/Taz contribute to the normal maintenance, tumorigenesis and regeneration of fully functional motor and sensory nerve in adult.

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### Therapeutic potential of Cannabinoids for Pain and Cognition

Sara Jane Ward  
saraward@temple.edu  
LKSOM  
Neural Sciences

My laboratory currently studies the therapeutic potential of non-psychoactive cannabinoid compounds for the treatment of nervous system disorders, including neuropathic pain, neuroinflammation, cognition, and substance abuse. We use mouse and rat models of these disorders to investigate the safety and effectiveness of constituents of the Cannabis plant, assessing behavioral and molecular outcomes.

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Role of Methamphetamine and/or HIV in Brain Damage

METH, a potent addictive psychostimulant, is one of the most abused drugs in the United States. METH abuse is highly prevalent in HIV-infected individuals, which presents unique challenges for HIV prevention and treatment. Given the overlap impact of METH use and HIV on neuronal damage in the CNS, it becomes urgent to understand the role of interplays between METH and HIV in the pathogenesis of HIV associated neurocognitive disorders (HAND). The goal of this project is to address the hypothesis that METH use and/or HIV infection inhibits host innate immunity and facilitates inflammation. There are two specific aims: 1. To examine whether METH and/or HIV inhibit the intracellular viral restriction factors in newly established brain cell model (iPSC-derived microglia and neurons). 2. To determine whether METH and/or HIV infection induce expression of the inflammasomes/neurotoxic factors and promote the death of neurons.

Clinical significance of this project. To understand how two major pathologic factors (HIV and METH) compromise the brain immunity and facilitate neuronal death should improve and advance our knowledge for developing therapies to prevent or eradicate HIV infection and persistence in the brain.

Students will: 1. Learn techniques such as RT-PCR, cell culture, western blot, flow cytometry assay, and data analysis; 2. Do a small and feasible research project: to examine if stem cell-derived microglia and neuronal cell produce interferons (IFNs) and IFN-stimulated genes. 3. understand importance of paying a great attention to details.

Location: HSC; In-person essential

Student Majors Accepted: High motivation for science, responsible and reliable, hard working

Class Preferences: Sophomores, Juniors & Seniors

Important Selection Criteria: Molecular biology, Genetics, Biology, Neuroscience

Study sexual dimorphism of metabolic disease

Multiple projects. Studying how elevated androgen regulates metabolic function (brain, liver, adipocytes) and reproductive function (pituitary and ovary), using mouse model to mimic human disease such as transgender female and polycystic ovary syndrome.

Location: HSC; In-person essential

Student Majors Accepted: Biology

Class Preferences: Sophomores & Juniors

Important Selection Criteria: Motivation and responsibility
**Combinatorial effects of ionizing radiation and cannabinoids against Glioblastoma multiforme**

Glioblastoma multiforme (GBM) is the most common primary brain tumor in adults and has a nearly fatal outcome in both children as well as adults. Despite the best possible treatments available, the median survival after diagnosis is usually 12 to 15 months and there has not been significant improvement over the past two decades. Since primary or acquired resistance of various tumors to conventional treatment regimens, till now constitute a major concern in cancer therapies, alternative strategies to target tumor cell resistance are of prime importance to improve patient outcome. Several studies showed that the effect of RT can be enhanced if combined with certain alternative modes of treatment. During the past two decades, such combination therapies have made great strides in cancer treatment. One of the alternative modes of cancer therapy that has been picked up momentum recently includes, use of certain alkaloids especially cannabinoids (functioning as synergizers or radiosensitizers or even tumor cell killers) with appropriate conventional treatments. In this investigation attempts will be made to determine the cellular and molecular effects of cannabinoids (tetrahydrocannabinol [THC] and cannabidiol [CBD]) in combination with ionizing radiation (IR) on Glioblastoma multiforme.

**Location:** HSC; Virtual or computational research  
**Student Majors Accepted:** Biology, Biochemistry, Bioengineering  
**Class Preferences:** Freshmen, Sophomores & Juniors  
**Important Selection Criteria:** Genuine interest in cancer biology, previous lab experience not essential. Research maybe Virtual and/or in-person

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**Renal dysfunction after Lung Transplantation**

A decline in renal function in the first 6 months after heart or lung transplantation progressively worsens in subsequent years. Furthermore, up to 5% of patients eventually progress to end-stage renal disease (ESRD) requiring permanent renal replacement therapy. The prevalence of renal failure following lung transplant is 26% and 38%, at 1 and 5 years, respectively. However, little is known about the prevalence of RF in the immediate post-operative period following lung transplantation and the long-term consequences of peri-operative RF. This project seeks to determine the prevalence of RF in lung transplant recipients, to identify pre-operative and intra-operative predictive factors for RF, and to assess the effects of RF on long-term renal function and survival.

**Location:** HSC; Virtual or computational research  
**Student Majors Accepted:** Biology, Premed  
**Class Preferences:** Freshmen, Sophomores, Juniors & Seniors  
**Important Selection Criteria:** N/A
Prostate Cancer in Renal Transplant recipients

An increasing number of older patients are being transplanted and as the longevity of the transplanted patients increases, there is an increase in risk of developing prostate cancer. This project aims to determine risk factors for developing prostate cancer in patients with kidney failure and following kidney transplantation.

Location: HSC; Virtual or computational research
Student Majors Accepted: All majors
Class Preferences: Freshmen, Sophomores, Juniors & Seniors
Important Selection Criteria: Data science skills preferred but not an absolute requirement.

Antibiotic Resistance Plasmids in the Microbiota

Antibiotic resistance plasmids can be found in the gastrointestinal microbiota (GI), however, the reason they are present in healthy microbiota is unclear. Our laboratory studies how antibiotic resistance plasmids can be carried as part of the commensal Enterococcus faecalis community in the GI tract. Projects include understanding how our model antibiotic resistance plasmid pCF10 can enhance the survival of commensal Enterococci in the GI tract. Determining how pCF10 can make Enterococci more virulent by changing the structure of their biofilms. In collaboration with Dr. Queisser in the Mathematics, we use confocal microscopy to develop computational models to study how biofilm structures influence movement of antibiotics and antibiotic-resistant plasmid transfer events in the GI microbiota.

Location: HSC; In-person essential
Student Majors Accepted: Biology, Chemistry
Class Preferences: Freshmen, Sophomores, Juniors & Seniors
Important Selection Criteria: The laboratory accepts students with any level of training and experience.
Causal pathways of overuse injury

To determine in young adult rats, using our operant model of overuse injuries: (a) causal pathways in overuse MSKIs, focusing on roles of poor sleep, inflammation and fibrosis; (b) whether sleep has a role in moderating pain intensity/persistence; and (c) whether undisturbed sleep or whole body exercise, and reduced fibrosis using a novel antibody against a fibrogenic molecule (anti-CCN2), or a combination, effectively reduces pain and improves function.

Location: HSC; In-person essential
Student Majors Accepted: Biology, or health science related degree
Class Preferences: Juniors & Seniors
Important Selection Criteria: Western blot/electrophysiology or microscopy skills (or desire to learn)

Mitochondrial Calcium Exchange in Heart Disease

Mitochondrial calcium exchange plays a critical role in regulating cellular bioenergetics, but also contributes to cell death. The overall goal of this project is to understand how alterations in mitochondrial calcium exchange contribute to cardiac injury and heart failure. Our lab has generated numerous genetic mouse models to knock out or overexpress the genes facilitating mitochondrial calcium uptake and efflux in the heart, and we are currently using surgical models of heart failure to assess how perturbation of these pathways protects or predisposes to heart disease. We are also taking in vivo and in vitro approaches to understand the molecular mechanisms that regulate the activity of these calcium handling proteins in order to understand how they could be targeted therapeutically. Students will gain experience in standard cell and molecular biology techniques as well as mouse handling, genotyping, and cardiovascular phenotyping. We seek driven, dependable individuals for this project.

Location: HSC; In-person essential
Student Majors Accepted: Biochemistry, Biology, Chemistry, Neuroscience
Class Preferences: Freshmen, Sophomores & Juniors
Important Selection Criteria: Priority placed on previous molecular biology laboratory experience. Self-motivated, hard-working individuals with a desire to learn are a must.
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Myeloid cell responsiveness to cardiac injury

We are investigating the impact of altered receptor expression/signaling in myeloid cells on their responsiveness to cardiac injury. The URP student will be involved in assessing markers of cardiac injury and remodeling via immunohistochemical and biochemical/molecular biology assays.

Location: HSC; In-person essential
Student Majors Accepted: Biology, Chemistry
Class Preferences: Sophomores, Juniors & Seniors
Important Selection Criteria: Previous research lab experience a plus

The role of ADGRs in the heart

We are investigating the impact of a new class of receptors, adhesion G protein-coupled receptors, on cardiac function and remodeling during heart failure. The URP student will be involved in analyzing echocardiography data for function and immunohistochemical and molecular biology readouts will be used to assess remodeling parameters. Some in vitro work to assess receptor activity/responsiveness may also be pursued.

Location: HSC; In-person essential
Student Majors Accepted: Biology/Chemistry
Class Preferences: Sophomores, Juniors & Seniors
Important Selection Criteria: Previous research lab experience a plus.
**Development of drug delivery systems with enhanced in vivo stability**

Drug delivery systems can modify the pharmacokinetics of drugs, protect them from decomposition and control their spatial and temporal delivery in the organism. In recent years we were involved in the development of drug delivery systems based on amphiphilic compounds of different molecular weight, from simple surfactants, gemini surfactants, lipids, dendrons and polymers. We are currently seeking talented and highly motivated students to develop the next generation of drug delivery systems with enhanced in vivo stability capable of long circulation time in the human body. Students majoring in chemistry, biochemistry and biology are welcomed. Experience in working with cells and animal models is a plus but it is not required.

**Location:** HSC; In-person essential  
**Student Majors Accepted:** Chemistry, Biochemistry, Biology  
**Class Preferences:** Freshmen, Sophomores, Juniors & Seniors  
**Important Selection Criteria:** General knowledge in chemistry, biochemistry, biology and especially in the interdisciplinary integration of this knowledge is needed.

**Synthesis, physicochemical and biological evaluation of novel carbonic anhydrase inhibitors, activators and their pharmaceutical formulations**

Carbonic anhydrases (CAs, E. C. 4.2.1.1) are a class of ubiquitous metalloenzymes that catalyze the reversible hydration of carbon dioxide: \( \text{CO}_2 + \text{H}_2\text{O} \leftrightarrow \text{HCO}_3^- + \text{H}^+ \). Fourteen isozymes are currently known in humans, with different catalytic activity, subcellular localization and tissue distribution. These isozymes are involved in critical physiologic and pathologic processes including respiration, acid-base regulation, electrolyte secretion, bone resorption/calcification, gluconeogenesis, tumorigenicity and the growth and virulence of various pathogens. Some of them are over-expressed in pathological conditions such as edemas, glaucoma, obesity and cancer. Therefore CA isozymes have become important targets for pharmaceutical research. We are seeking talented and passionate individuals to be involved in the synthesis, physicochemical and biological testing of novel selective CA inhibitors and of their pharmaceutical formulations aiming towards treatment of various forms of cancer via novel drugs and drug delivery systems.

**Location:** HSC; In-person essential  
**Student Majors Accepted:** Chemistry, Biochemistry, Biology  
**Class Preferences:** Freshmen, Sophomores, Juniors & Seniors  
**Important Selection Criteria:** Previous experience in synthesis, physicochemical and/or biological evaluation of organic compounds and their formulations, as well as towards tissue cell cultures constitutes a plus.
### Development of nanomaterials and nanodelivery systems for treatment of drug-resistant diseases

A number of infectious diseases are difficult to treat because the causative micro-organisms tend to hide in the body parts (e.g. brain, bone) that are poorly accessible by the conventional therapeutic agents (e.g. small molecule drugs). Our group focuses on (i) developing new materials that are suitable for preparing nanoscaled drug delivery systems; (ii) designing, developing and characterizing novel nanocarriers for delivering therapeutic agents to the poorly accessible body parts in efficient and specific manner. Based on the student’s preference, the student will be involved in synthesis of nanomaterials and/or developing new nanocarrier systems.

**Location:** HSC; In-person essential  
**Student Majors Accepted:** Biology/ Chemistry/ Biochemistry/ Bioengineering  
**Class Preferences:** Sophomores, Juniors & Seniors  
**Important Selection Criteria:** Students with chemistry/ biology background are preferred. Experience in chemical synthesis/ cell or micro-organism culture is valuable (not strictly required). Responsible and diligent.

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### Development of nanocarrier for treatment of drug-resistant infectious diseases

A number of devastating infectious diseases often become resistant to standard drug therapy because the micro-organisms (such as bacteria and virus) tend to hide in poorly accessible locations such as brain and bone. Delivering anti-infective agents using nanoscaled drug carriers may significantly enhance the drug penetration to and specificity for these disease sites. Student(s) who join this project will be responsible for (i) development of nanomaterials for preparation of these drug delivery systems; and/or (ii) development and characterization of nanodelivery systems for treatment of these drug-resistant micro-organisms.

**Location:** HSC; In-person essential  
**Student Majors Accepted:** Chemistry, Biology, Microbiology, Bioengineering  
**Class Preferences:** Sophomores, Juniors & Seniors  
**Important Selection Criteria:** Student(s) with previous lab experience about chemical synthesis, cell culture, and/or micro-organism culture are preferred. Self-motivated, responsible students are welcome.